

NASA TECH BRIEF

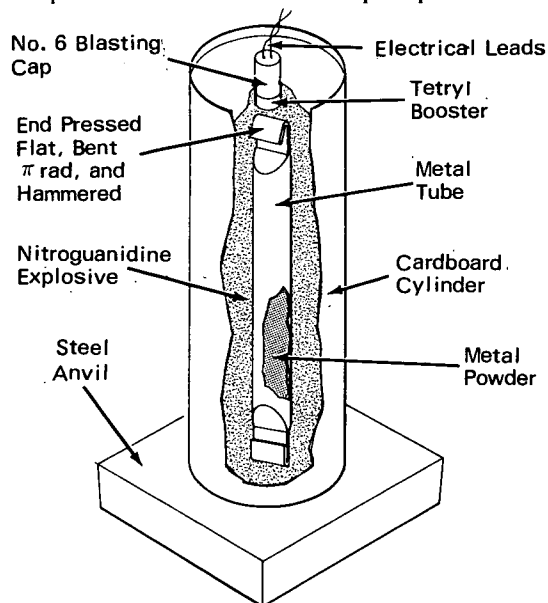
Marshall Space Flight Center



NASA Tech Briefs announce new technology derived from the U.S. space program. They are issued to encourage commercial application. Tech Briefs are available on a subscription basis from the National Technical Information Service, Springfield, Virginia 22151. Requests for individual copies or questions relating to the Tech Brief program may be directed to the Technology Utilization Office, NASA, Code KT, Washington, D.C. 20546.

Unique Intermetallic Compounds Prepared by Shock Wave Synthesis

A new materials fabrication technique uses explosion-generated shock waves to compress a mixture of fine ground metallic powder beyond the crystal fusion point. The absence of vapor pressure voids



Set-Up for Explosive Compaction of Metal Powders

and the elimination of incongruous effects which sometimes attend incomplete particle fusing may permit this technique to be applied to the large scale fabrication of intermetallic compounds with specifically formulated characteristics; e.g., semiconduction, superconduction, or magnetic properties. This method of synthesis should prove valuable to industries engaged in pyrometallurgy and materials fabrication.

The practice of powder compaction is used on a wide variety of powdered materials, including metals, refractory compounds, ceramics, and cermets. Emphasis is placed on achieving high theoret-

ical compact densities (94 to 98%), and on producing various compact shapes and sizes. Techniques such as isostatic pressing and direct pressure compaction of metallic powders, followed by furnace sintering, melting and/or casting, are very expensive due to the large capital outlays required for the high temperature furnaces, hydraulic presses, furnace atmosphere controls, and laboratory or plant buildings.

This new method requires mixing high purity metal powder particles in the atomic proportions essential to produce the desired intermetallic compound. The mixed powders are then introduced into a metal tube which is closed, but not sealed, at each end so that gases generated during explosive densification and/or compaction can be expelled. This metal tube is then inserted into a cardboard cylinder and surrounded with an explosive, as shown in the figure. The cylinder can be made of any material strong enough to contain the explosive powder while retaining its cylindrical shape up to the time of detonation.

After the cylinder and the tube have been loaded and assembled, an electric detonator is centrally positioned in one end of the cylinder and is detonated. Upon reaching the inner metal tube containing the metal powders, the explosive front continues as an annular pressure wave develops into a high-velocity conical shock-wave having pressures in excess of 100 kilobars, which overcomes the bonds between the powder particles and results in high densification, grain strength, and deformation of the particles. The resultant powder compact produced is, in effect, pressure quenched as a function of the high rate of pressure decay; i.e., the superficial particle melting is quenched and resolidified in microseconds.

To confirm the applicability of this new technique for the synthesis of superconductive intermetallics,

(continued overleaf)

Nb₃Al was produced and evaluated. A superconductive threshold of 16.3 K was attained on the intermetallic produced, and was confirmed by subsequent tests.

Notes:

1. No vacuum operation (melting, heat treatment) is needed since the reaction occurs extremely fast. Compounds which cannot be fabricated by conventional techniques can be synthesized by the compressive shock waves, and the time required to produce these metallic compounds is reduced from days or hours to microseconds. However, extreme caution must be exercised due to the possibility of spontaneous combustion of the powder. Also, for safety reasons, the process should be carried out in an explosion-proof enclosure.

2. No additional documentation is available. Specific questions, however, may be directed to:
Technology Utilization Officer
Code A&TS-TU
Marshall Space Flight Center
Huntsville, Alabama 35812
Reference: B71-10216

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to:

Patent Counsel
Mail Code A&TS-PAT
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

Source: Dr. G. Otto and O. Y. Reece
Marshall Space Flight Center
and Dr. U. Roy of
University of Alabama
under contract to
Marshall Space Flight Center
(MFS-20861)